DOCUMENT RESUME

ED 312 123 SE 050 877

AUTHOR Manno, Bruno V.; Winters, Kirk
TITLE The State of Mathematics and Science Education in America and What the U.S. Department of Education is Doing about It: A Guide to Mathematics and Science Programs Administered and Supported by the Department.
INSTITUTION Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE Jul 89
NOTE 20p.; Broken type may not reproduce well. Best available copy.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS College Mathematics; College Science; *Demonstration Programs; *Educational Administration; *Educational Finance; Elementary School Mathematics; Elementary School Science; Elementary Secondary Education; Higher Education; *Mathematics Education; Science Education; *Science Programs; Secondary School Mathematics; Secondary School Science; *Statistical Surveys
IDENTIFIERS *Department of Education

ABSTRACT

Activities and programs administered by the Department of Education that are related to science and mathematics education are described. Funding and exemplary programs for improving mathematics and science education are summarized, including the Dwight D. Eisenhower Mathematics and Science Education Program; the National Diffusion Network; the Chapter 1 Program; and the Fund for the Improvement of Postsecondary Education. The department's research, development, dissemination, and statistics-gathering activities are outlined, including national research and mini-centers; the ERIC Clearinghouse for Science, Mathematics, and Environmental Education; nine regional laboratories; and the National Center for Education Statistics. The President's initiatives and budgets for mathematics and science education are discussed. (YP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED312123

The State of Mathematics and Science Education in America and What the U.S. Department of Education Is Doing About It: A Guide to Mathematics and Science Programs Administered and Supported by the Department

Bruno V. Manno
Acting Assistant Secretary
OERI

Kirk Winters
OERI Associate

July, 1989

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

✗ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SE 050 877

BEST COPY AVAILABLE

The State of Mathematics and Science Education in America and What the U.S. Department of Education Is Doing About It: A Guide to Mathematics and Science Programs Administered and Supported by the Department
July 1989;
Bruno V. Manno, Acting Assistant Secretary, OERI
Kirk Winters, Senior OERI Associate

Over the last year or so we've all seen headlines and heard news reports about how poorly American students are doing in mathematics and science. When compared with students in 12 other countries, our high school students finished 9th in physics, 11th in chemistry, dead last in biology. In a recent study of five countries and four Canadian provinces, U.S. 13-year-olds came in last in mathematics and near last in science.

The competition is clobbering us. Nor are our students learning enough in absolute terms. Only about half of our high school juniors can do junior high math--tasks such as calculating the area of a rectangle or estimating 87 percent of 10. Just one in four black and Hispanic 17-year-olds performs at the junior high level in mathematics.

In science, fewer than half of our 17-year-olds seem to know enough "to perform...jobs that require technical skills or to benefit substantially from specialized on-the-job training," according to the National Assessment of Educational Progress. It tells that fewer than half appear to be adequately prepared in science "for informed participation in the nation's civic affairs." Only about half of majority or white juniors can evaluate experiments and interpret texts and graphs. Fewer than 15 percent of black and Hispanic juniors can do these things.

I present this snapshot of student performance because performance is what matters; student learning is the yardstick by which our curriculum, textbooks, teachers--our entire education system--must be measured. Such information comes from the National Center for Education Statistics. In fact, all the data I've just cited comes from projects NCES supports, namely the National Assessment of Educational Progress (NAEP) and studies conducted through the International Association for the Evaluation of Educational Achievement (IEA).

Your invitation asked about Departmental efforts to coordinate activities with other agencies, so let me supply a little more evidence about the performance of our education system that, while less scientific in design, is nevertheless revealing. A year ago, the Department of Education joined with the Departments of Labor and Commerce to take a look at America's workforce. During the spring of 1988, 134 business

representatives and 34 educators across the nation were interviewed, the results of which are available in a publication issued jointly by those Departments, Building a Better Workforce. Interviewers found that "Employers are practically unanimous in their concern that competencies of entry level workers are deficient." According to the report, "the `basic skills gap' between what business needs and the qualifications of the entry level workers available to business is widening." Motorola, for example, reported that only one out of five of its applicants can pass a simple 5th grade math test. What do these business people want entry-level employees to know in mathematics? The report tells that "nine out of 10 employers consulted indicated that entry level positions require a solid basic mathematical foundation"--fractions, decimals, proportional relationships, metric measurements.

Of course, the workplace is not the only place where knowledge and competence in mathematics are needed. Without the ability to calculate percentages and volume, how can anyone compare the interest on car loans, the cost of various health care programs, or unit prices at the grocery store? How can citizens read newspapers and understand news reports on crime rates, interest rates, global warming, acid rain, overpopulation, AIDS, the nation's defense, and a host of other issues--how can they recognize, let alone support, sound public policies--without a rudimentary grasp of logic, probability, statistics, or the physical and biological sciences? If this nation is to advance toward its egalitarian ideals, most all our citizens need considerably more knowledge and competence in science and mathematics than they're acquiring in our education system today.

What's the problem? Why aren't our schools producing graduates possessing higher levels of mathematical and scientific knowledge? In his speech to the Council of Scientific Society Presidents in December, Secretary Cavazos pointed to five reasons American students are not learning enough in these critical areas:

1. Time: Our elementary schools teach only about a third to half as much science as do schools in other advanced nations. In high school, our students get an average of about two-and-a-half years of science. Compare that to the Soviet Union, where students reportedly take six years of biology, five years of physics, and four years of chemistry. Now, compared with American students five or ten years ago, our students today, as a whole, are taking more science and mathematics courses in high school. A report released in February by the Center for Policy Research in Education (supported by OERI) found that in recent years, 42 states have added requirements in mathematics, science, or both. The impact shows up on student transcripts. The transcript study I mentioned a bit ago shows that the average high school

graduate in 1987 had taken nearly 3 years of mathematics (2.97 credits), up from just 2-and-a-half years five years earlier, in 1982 (2.54 credits). That same study shows that the average 1987 high school graduate had studied over two-and-a-half years of science (2.59 credits), up from 2.19 credits in 1982. But most of the new courses added (and, one must assume, most of the additional courses taken) "were overwhelmingly at the basic, general, or remedial level," according to the Center for Policy Research in Education analysis. Specifically, the transcript study shows that not even two out of three 1987 graduates took geometry, less than half (47 percent) took Algebra II, only one out of five took trigonometry, about one out of 20 made it to calculus, not even half took chemistry (45 percent), and just one out of five took physics.

2. Curriculum: Just about everyone is calling for a revision of the curriculum. Recent months have seen the National Council of Teachers of Mathematics release their "Curriculum and Evaluation Standards for School Mathematics" and the American Association for the Advancement of Science issue a curriculum framework for science, "Science for All Americans: Literacy Goals in Science, Mathematics, and Technology." Both are products of the labor of hundreds of individuals and many organizations representing experts in the field and educators. OERI is supporting research in mathematics and science curricula, which I'll talk about presently.

3. Instruction: We are supporting research in instruction in these two fields as well. Hands-on learning has been espoused by science and mathematics education groups for years now, and research suggests that using objects and "manipulatives" is an effective way to teach mathematics and science concepts. Yet student experiments and hands-on assignments have actually declined in recent years (by some estimates, as much as 27 percent in 10 years). A third of our seventh graders say they never get to do experiments.

4. Textbooks: Textbooks are influential; teachers rely heavily on them. In many schools, the textbooks steer the curriculum; they determine what is taught, and thus, what students have an opportunity to learn.

5. Teachers: Textbooks wouldn't be the de facto curriculum teachers were adequately prepared. Many elementary teachers say that they're uncomfortable teaching science and math. For good reason. While in college, many of the elementary teachers in our schools today completed only one or two courses--if any--in these two disciplines. Can you imagine trying to inspire students in a subject that is unfamiliar to you? Something must be done here. For if children do not enjoy science in the early grades (some say by the third grade), they're less likely to be willing to invest

the hard work and discipline that success in later science study demands.

There are problems in teaching at the secondary level as well. During the 1980s at least two-thirds of the states were unable to hire enough mathematics and science teachers. Sixty to 70 percent of junior high and high school principals say they have difficulty hiring teachers for physics, chemistry, and computer science classes. In one recent year, for every new science or math teacher that entered public schools, 12 quit. Nor is there relief in sight. During the next few years, our colleges and universities--which traditionally supply most of our teachers--will produce fewer than half the science and math teachers needed in American schools.

What happens when a qualified individual cannot be found to teach algebra or biology? Often, the principal has no choice but to hire someone without college coursework in the subject--someone who may know little more than students about the subject.

In view of this practice, known as "emergency certification" and common in most states, is it any wonder that our students know less about science and mathematics than students in many industrialized nations? Is it any surprise that a shortfall of a half a million scientists and engineers is forecast for the year 2010?

Those are some of the reasons our students are learning too little of what they need to know in science and mathematics. I'd like to look now at what the Department of Education is doing to turn this situation around.

As you know, our largest program aimed specifically at improving mathematics and science education is the Dwight D. Eisenhower Mathematics and Science Education program, for which the President has requested $142 million for fiscal year 1990, a 3.4 percent increase over the 1989 appropriation. The Eisenhower program consists of two parts: national programs and state grants.

Of the $142 million total, $9.2 million would support the Mathematics and Science National Programs, which are administered by the office of the Fund for the Improvement and Reform of Schools and Teaching. This program provides grants and cooperative agreements to a variety of institutions for projects of national significance in mathematics and science instruction. In 1988, 29 grants were awarded to projects serving students from populations underserved in mathematics and science and underrepresented in mathematics, science, and engineering fields. Grants averaged $500,000 at the secondary level, $100,000 at the elementary level. Most were for collaborative projects among school districts, universities,

science, museums, and the business community. One of those projects, the American Association for the Advancement of Science Resources for Schools (SRS) Project, is developing training for teachers to conduct after-school programs in science and mathematics for black and Hispanic children in grades 5 through 9 and for their parents. Another project will bring 20 teachers and 60 American Indian junior high students to the Colorado School of Mines campus in Golden, Colorado for three weeks this summer to provide guest speakers, field trips, equipment, and lots of hands-on learning for students and teachers.

Also in 1988, National Programs provided support to educational television programming (3-2-1 Contact! and Square One) and the National Center for Improving Science Education. Administered by OERI, the national center (in its second year of a three-year contract) is synthesizing research and promoting policy improvements in science curricula, instruction, and assessment.

As for 1989, a competition is currently under way for projects to develop secondary schools with exemplary curricula in mathematics and science. We expect to make about ten awards averaging $600,000. A competion is being held for projects to improve mathematics and science instruction at the elementary school level. About twenty awards averaging $100,000 will be made. Panels of individuals outside the Federal government are currently reading and evaluating the 471 applications received for the two competitions. Awards are expected to be made this summer.

For 1990, a 3.4 percent increase has been requested for the Mathematics and Science National Programs. Depending upon the response to the 1989 competition for exemplary secondary curricula in mathematics and science, another may be held in 1990 to encourage the establishment of additional schools offering specialized curricula in mathematics and science. Other competitions designed to demonstrate nationally significant approaches to improving the nations' mathematics and science performance would also be held.

With National Programs funds, a two-year study of of the "state grants" program was begun in 1988. The first comprehensive investigation of this state grant program, it is aimed to answer two broad questions: what have funds been used for, and what has been their impact? The report, which is expected to be released in the autumn of 1990, will illustrate typical practices and exceptional uses of funds and thereby furnish us with a national profile of the state grants program. The Office of Management and Budget, the National Science Foundation, the Council of Chief State School Officers, and hundreds of individuals from state and local agencies as well as the U.S. Department of Education are involved as advisory panel members. The study is being administered by the Department's Planning and Evaluation

Services under contract to SRI International.

The President has requested $132.8 million in fiscal year 1990 for Mathematics and Science education state grants (administered by the Office of Elementary and Secondary Education), a 3.4 percent increase over 1989. The average state grant would be about $2.5 million, ranging from as low as $657,000 to as high as $13 million, depending on the number of children aged 5 to 17 (which determines half the total granted a state) and on the Chapter 1 allocation of the previous year (which determines the other half of the state's grant).

Under this program, which was created for the purpose of improving the skills and knowledge of teachers and the quality of instruction in mathematics and science, 75 percent of each state grant must go to elementary and secondary programs, 25 percent for higher education programs. Over 90 percent of all local education agencies and approximately 1500 colleges and universities have participated directly in the program. In the past, about 80 percent of the funds have been used for teacher in-service training. Funds may also be used, however, to expand or improve preservice training and retraining of teachers in mathematics and science; to recruit or retrain minority teachers to become mathematics and science teachers; to train teachers in the use of technologies as part of a matehmatics or science program; to integrate higher-order thinking into the mathematics or science curricula; or to support projects for individual teachers to improve their performance or instructional materials. The 25 percent for higher education goes to colleges and universities for establishing traineeship programs for new secondary school matthematics and science teachers; for retraining secondary school teachers in mathematics and scinece; and for inservice training for elementary, secondary, and vocational teachers in mathematics and science.

In applying for a state grant, each state must include a projection of the supply and demand for teachers within the state in all mathematics and science areas and an assessment of current elementary and secondary mathematics and science curricula. Local education agencies seeking a grant under this program must submit an application to the state that includes an assessment of the needs of its current mathematics and science teachers and whether a shortage of qualified teachers exists or will exist within five years; the current levels of mathematics and science student achievement in the local education agency area; and the curricular needs in mathematics and science in that area.

Such information is important. According to one state estimate, approximately 60 percent of its middle/junior high teachers of mathematics are teaching with what the state considers to be "insufficient mathematics background."

Another applicant wrote that "most teachers in the primary and middle school grades have not had training in science and mathematics" and that about 70 percent of the middle grade teachers in their particular county fall into that category.

Let me mention just two exemplary local programs from the 100 such programs that the Department of Education, with the help of the states, identifies and disseminates information about each year. The Woodrow Wilson Fellowship Foundation Institute in New York State provided one-week institutes for 115 high school teachers of chemistry, mathematics, and physics, taught by three teams of master teachers in these disciplines. The New Jersey Algebra Project has trained hundreds of teachers and has provided thousands of students with a discovery-oriented curriculum that emphasizes classroom discussion and participation by all students in the classroom. Assessments show that Algebra Project students learn algebra more successfully than do students taught by traditional curricula.

One of the Department's priorities during the past year and a half was to increase collaboration--to encourage K-12 education agencies and higher education agencies within each state to work more closely in identifying the state's needs with regard to mathematics and science education--and in meeting those needs. At the national level, Department staff in the Office of Elementary and Secondary Education administering the state grant program have secured more input and advice from the National Science Foundation, the Department of Energy, NASA, and other Federal agencies. For example, at the Annual National Conference of Title II State Coordinators, NSF staff set up an exhibit, distribute documents, and are responsible for about a half-day of the conference program. OESE staff participate in NSF-sponsored conferences and review applications to NSF for programs of national significance.

In addition to the state grants and national programs under the Dwight D. Eisenhower Mathematics and Science Education authority, the Department administers a number of other programs that, while not aimed directly at science or mathematics or engineering education, nevertheless have an impact on teaching and learning in these disciplines.

In the area of "school improvement programs" is the National Diffusion Network, a $11.2 million program administered by OERI that helps make available to schools, colleges, and other institutions hundreds of exemplary programs, many of which are mathematics and science programs. In each of the last few years, NDN has issued a booklet of quality mathematics programs and a companion booklet of outstanding science programs. As a result of these publications and a national network of developer-demonstrators and facilitators, thousands of NDN programs have been adopted

by schools and school districts. The Cosmos Corporation Project, which is funded by NSF, has helped with this effort.

Also administered by OERI, the Elementary School Recognition Program in 1987-88 decided to award bonus points to schools that showed evidence of having a solid mathematics and/or science program. One-third of the schools making the finals in the 1987-88 competition earned bonus points for such programs. The OERI Recognition Division worked closely with NSF in identifying and assessing these programs.

Another program administered by OERI, the Fund for Innovation in Education (FIE), will make about $6 million available in grants for training teachers and administrators to use technology in classroom instruction, particularly in mathematics and science. Similarly, the Fund for the Improvement and Reform of Schools and Teaching (for which the President has requested $5.9 million), while aimed not exclusively at mathematics and science education, will focus on improving school and teacher performance and family-school partnerships and thus is likely in a fair number of instances to help strengthen teaching and learning in mathmatics and science. Star Schools, which OERI also administers, provided $19 million in 1988 to four regional partnerships for developing teaching networks that use live interactive instruction via satellite, individualized computer-assisted instruction, and videotaped instruction to deliver to students in more than 1000 schools in 39 states courses in mathematics, science, and foreign languages where such courses are otherwise unavailable. Also, it is expected that a fair number of the 25 to 30 discretionary grants to be awarded under the $6.2 million Jacob K. Javits Gifted and Talented Students Education Act will focus on math and science.

While on the topic of gifted youngsters, let me mention a report the Department issued in April, No Gift Wasted. It looks at nine programs that are successful in serving able, disadvantaged students.

I would be remiss if I did not mention the Department's largest elementary-secondary program, Chapter 1. Administered by OESE, Chapter 1 reaches virtually every school district in the nation and one out of nine students enrolled in U.S. elementary and secondary schools. With just under half of these students receiving mathematics instruction, I have to think that Chapter 1 has or ought to have a considerable impact on mathematics learning in America.

As for undergraduate education, the Department's Office of Postsecondary Education (OPE) administers two relevant programs. The President is requesting $11.9 million in fiscal year 1990 for The Fund for the Improvement of Postsecondary Education (FIPSE), which awards small discretionary grants and

contracts to postsecondary institutions for the purpose of stimulating improvements in postsecondary education. In fiscal year 1988, FIPSE funded 47 projects related to science, mathematics, and engineering. A program at the University of California, Berkeley, for instance, is helping 15-20 colleges and universities adapt a retention program that has promoted high levels of achievement in mathematics and high persistence rates among minority undergraduates at Berkeley. Another FIPSE-supported program, at Fairleigh Dickinson University (New Jersey), prepares mid-life science and technical professionals for new careers in secondary school science and mathematics teaching through a one-year teaching internship. In 1989, 86 new and 100 non-competing continuation grants will be awarded through FIPSE.

The other program is the Minority Science Improvement Program (MSIP), for which the President has requested $5.5 million, a 3.4 percent increase over the fiscal year 1989 appropriation. This program offers four kinds of grants: institutional project grants, which assist individual minority institutions in implementing comprehensive science improvement plans; cooperative project grants, which assist groups of nonprofit, accredited colleges and universities in working together in conducting science improvement programs; design projects grants, which support minority instituions' efforts to plan and develop long-range science improvement programs; and special project grants, which support activities aimed to improve the quality of training in science, mathematics, and engineering, enhance minority institutions' general scientific research capabilities, provide needed services to groups of eligible minority institutions, or provide inservice training for project directors and faculty from eligible minority institutions.

There are two other postsecondary programs I'd like to mention, both of which are administered by the Department's Office of Postsecondary Education. The Patricia Roberts Harris Graduate Fellowships are awarded to institutions of higher education to assist indviduals from groups traditionally underrepresented in colleges and universities to undertake graduate and professional study. Institutions recruit such individuals and award fellowships for them to pursue advanced degreees in academic areas. The President has requested $16.2 million in fiscal year 1990 for this program. The other program is the Graduate Assistance in Areas of National Need Program, for which the President is seeking $11.9 million. This program provides fellowships to assist financially needy graduate students of superior ability studying in areas of national need, as designated by the Secretary in consulation with NSF, the National Academy of Sciences, the National Endowments for the Arts and Humanities, and other federal and nonprofit agencies and organizations.

I'd like to turn now to the Department's research,

development, dissemination, and statistics-gathering activities.

The Office of Research within OERI administers 21 national research centers and mini-centers, for which the President is requesting $18.3 million in 1990. At least 10 of the centers and mini-centers are engaged in efforts to improve mathematics or science education. (The difference between a "center" and a "mini-center": Mini-centers are funded at $500,000 for three years whereas full centers are generally funded at about $1 million for five years.)

The Center for the Study of Learning (at the University of Pittsburgh) has four projects under way in mathematics, two in science. Under one project, the center is identifying intuitive mathematical knowledge that youngsters from various backgrounds bring to the classroom--knowledge that can serve as a foundation for helping all students learn proportions and ratios, negative numbers, and other formal mathematics. The center's research in the effectiveness of collaborative learning (in arithmetic story problems) suggests that pairing students of the same ability and supplying them with memory/organizational tools can increase their performance in solving word problems. A third project indicates that inadequacies in teacher knowledge (knowledge pertaining to functions and graphing) limits teacher effectiveness in presenting lessons and in drawing connections between "pieces" of knowledge.

One of the center's science projects explores the use of computer-based "micro-worlds" to help students learn about refraction of light; microeconomics; and voltage, current, and resistance in direct current circuits. The other science project, a study of how biology textbooks present the topic of the human circulatory system, points to critical omissions in textbooks--omissions that parallel students' misconceptions about the circulatory system (from second to tenth grade).

The Center for the Learning and Teaching of Mathematics (a mini-center at the University of Wisconsin at Madison) is pursuing two lines of inquiry: applying what is known about students' cognition to improving classroom instruction and strengthening curricula and assessment--that is, identifying fundamental knowledge that should be taught to all students, organizing and sequencing that knowledge, connecting mathematics to other subjects, and narrowing the gap between the prescribed curriculum (what is <u>supposed</u> to be learned) and the achieved curriculum (what is <u>actually</u> learned).

The National Center for Improving Science Education (a mini-center at The Network, Inc., Andover, Massachusetts), which I mentioned earlier, is synthesizing research on the scientific knowledge and skills that tests currently measure and <u>ought</u> to measure, the content of science curricula and

instruction, and the knowledge and skills of teachers--how their preparation, staff development opportunities, and school and school district structures support the teaching of science. This mini-center is funded out of the Dwight D. Eisenhower Mathematics and Science Act (National Programs).

The Center for the Learning and Teaching of Elementary Subjects (a mini-center at Michigan State University) is identifying exemplary practices for teaching problem-solving and higher-order thinking and will recommend improvements in the selection of course content, instructional materials, pedagogy, and assessment strategies for teaching science and mathematics (as well as in other academic subjects at the elementary school level).

All three mini-centers (for mathematics, science, and elementary subjects) will expire in calendar year 1990. In fiscal year 1990, the Office of Research will support efforts to identify ways of teaching mathematics and science to different groups of students in various school settings.

The Center for Research on Evaluation, Standards, and Student Testing (University of California, Los Angeles) is investigating strategies and formats for measuring higher-order thinking in mathematics, techniques for examining the instructional sensitivity of mathematics test items or questions, and procedures for assessing content coverage and test impact in secondary mathematics classrooms.

The Center for Technology in Education (Bank Street College of Education in New York City) is studying the design and delivery systems of instructional strategies (in science, specifically astronomy, and other subjects) that employ advanced technologies. The goal of this inquiry is to identify optimal ways to integrate technology into schools under a variety of conditions.

One of the projects at the Center for the Study of Writing (University of California, Berkeley) involves examining the writing students do in science classes, in an effort to determine how instruction can best be structured to yield optimal gains in student performance in writing and in science.

The National Center for Research on Teacher Education (Michigan State University) is examining what teachers learn in various kinds of training and preparation programs--specifically, their knowledge and understanding of mathematics, their goals for mathematics instruction, their repertoire of strategies for teaching mathematics, and their ideas about the ways that diverse students learn mathematics. Preliminary findings from the center suggest that: 1) Mathematics majors, as well as teacher candidates, have difficulty working below the surface of so-called "simple"

mathematics; although they can perform the procedures, they seem to lack in-depth understanding of the content; 2) Teacher candidates rely on what they learned in precollegiate schooling (as distinct from college) when answering questions about particular tasks in teaching mathematics; 3) Whereas mathematics majors (both regular majors and those who are preparing to teach in secondary schools) demonstrate a facility in dividing fractions that is greater than that of elementary teacher candidates, they are not any better at explaining and connecting the concepts and principles underlying mathematics; and they have difficulty in devising real life problems that call for the use of particular mathematical procedures.

The Center for Research on the Context of Secondary School Teaching (Stanford University) is studying secondary school mathematics departments and science departments (as well as other academic departments within high schools) to determine how these departments function, particularly with regard to tracking, curriculum development, and testing. The center is also analyzing how several factors--students' and teachers' conceptions of knowledge, policies regarding curricula and testing--influence what is taught and learned in science, mathematics, and other disciplines.

The Center for Research on Elementary and Middle Schools (Johns Hopkins University) is conducting a project to increase our knowledge of how to devise classroom instruction and cooperative learning strategies so as to take into account student differences. It is also developing and evaluating methods of teaching students study strategies for improving their ability to learn general science and develop independent learning skills.

During the past several years, OERI has administered a number of competitive field-initiated studies. Two relate to science and mathematics: a study of black students' commitment to--and achievement in--mathematics and science, and a study aimed to reveal teacher-developed tests for high school science might be improved. Results of these two studies are expected in January 1990.

As for higher education, the Office of Research in OERI has sponsored five projects on the development of indicators of undergraduate learning in biology, chemistry, computer science, mechanical engineering, and physics. These two-year projects (which, for fiscal years 1986 through 1988, received a total of $328,000) produced models that enable us to examine what college graduates who major in one of these fields actually <u>know</u> in that field. These models, if implemented, could help reveal gaps in the undergraduate education of our scientific workforce. The models will be published as a collection this fall.

In fiscal year 1988, Office of Research staff conducted the first detailed study of the mathematics course-taking of a generation of college students. The study, which cost $5,400 (for computer time) plus OERI staff time, includes an examination of the relationship between the specific kinds of mathematics studied in college and what happened to the students in the labor market. The results were presented to the National Research Council in December; the full report will be published later this summer.

As a result of the mathematics course-taking study, NSF contributed $20,000 in fiscal year 1989 for Office of Research staff to conduct a detailed analysis of college student course-taking in over 200 specific course topics in science, engineering, mathematics, computer science, and engineering technologies. The intent of the study is to describe the scientific knowledge and preparation of all college-attending students within a given generation. Results should be completed by late summer.

OERI administers 16 ERIC clearinghouses, including the Clearinghouse for Science, Mathematics and Environmental Education (Ohio State University). Under the 1990 budget request, this Clearinghouse would receive roughly the same amount as in 1989, $314,000. The clearinghouse works with over 30 national associations and more than 200 federal, state, and local school agencies and organizations in: developing and maintaining its database of publications; producing syntheses and summaries of research (over 20 publications per year for the past several years); mailing bulletins, digests, and publication announcements to over 20,000 individuals, organizations, and agencies each year; providing user services to help people obtain information (over 25,000 contacts and requests per year); making over 40 presentations at conference, meetings, and seminars; publishing articles in journals; and collaborating on projects with associations, centers, organizations and agencies. In 1988, the clearinghouse assisted representatives of nearly every major national science and mathematics association, federal agencies (including USEPA, NSF, NASA, USAID, and the Departments of Energy, Agriculture, Defense, Commerce, and State), 40 state departments of education, personnel in over 2,000 school districts (including all of the 125 largest districts in the U.S.), and personnel in over 700 colleges and universities. The clearinghouse has also received requests and provided help to over 40 foreign countries. For instance, staff served as consultants for science, mathematics, and environmental education to Egypt and the Republic of China in 1988, and participated in seminars involving various Asian and European countries. In the first four months of calendar year 1989, the clearinghouse responded to more than 10,000 inquiries (an average of over 2500 per month) from teachers, principals, superintendents, librarians, students, school boards, scholars, college teachers and administrators,

university librarians and students, and government agencies at all levels.

Among the various publications in the works in OERI's Programs for the Improvement of Practice are two, one targetted to policymakers, the other to parents. The former is aimed to guide state and local policymakers to policies that promote effective science education. The booklet for parents will tell what they can do to get their children interested in science and to encourage the local elementary school to improve its science programs. Lots of practical tips will be offered--how to make a trip to the zoo or a museum more beneficial, how to locate good science-related books for children, and others. The publication is expected to be out this summer.

OERI administers nine regional labs, for which the President has requested $17.8 million in 1990. Most of the labs conduct workshops, issue publications, or provide technical assistance to improve instruction in mathematics and science.

The Southeastern Educational Improvement Laboratory, for instance, has sponsored several workshops on "Family Math" and hands-on mathematics programs. The lab also held a seminar that introduced state and local education agency staff in six states to a popular program designed to enrich K-5 mathematics instruction and to extend learning into the home ("Superstars II").

The Far West Laboratory for Educational Research and Development recently conducted a longitudinal evaluation of a K-8 math program in Utah, resulting in a "restructured" math program; trained about 50 science department heads, master teachers, and winners of the Presidential Awards for Science Teaching (an NSF program); planned a week-long summer workshop for science teachers on behalf of the Nevada Department of Education; and devised training possibilities for science teachers in California.

In the works at the North Central Regional Educational Lab is a policy brief on technology and education, with an estimated distribution of 6000 copies. Also forthcoming is a lab-sponsored publication, "Science Education in Rural America." Together with PBS, the lab presented a teleconference in April 1989 on "The Failure of Basic Skills: Who's at Risk?", which included segments on "Teaching Science for Conceptual Understanding" and "Making Sense of Mathematics."

Science- and mathematics-related activities in other regional labs include the Mid-Continent Regional Educational Lab's Math Applications course designed for students who do not take geometry or Algebra II; the Appalachia Educational

Laboratory's "bulletins" on mathematics and science publications; and the Northwest Regional Educational Laboratory's data base of evaluations of software programs designed to help teach various subjects, including mathematics and science.

The Department's National Center for Education Statistics (NCES) furnishes a wealth of data on issues related to mathematics, science, and engineering. The Integrated Postsecondary Education Data System ($1.9 million requested for 1990, a $300,000 decrease from 1989) collects information on the number of students receiving bachelor's, master's, and Ph.Ds in various fields of mathematics, the sciences, and engineering. NCES collects enrollment data by field of study biennially. The National Postsecondary Student Aid Survey ($3.5 million requested for the NPSAS in 1990, a $500,000 increase) supplies data on students' backgrounds and some of their educational experiences in various fields. NCES collaborated with NSF in developing aspects of the NPSAS of interest to NSF. The Recent College Graduate survey, now Baccaulaureate and Beyond, ($610,000 was requested for 1990, a $400,000 increase over 1988; no funds were allotted in 1989) provides information on employment status, earnings, and type of work for students with bachelor's degrees in various fields, including mathematics, science, and engineering. The National Survey of Postsecondary Faculty ($300,000 requested for 1990, a $200,000 increase over 1989) supplies information about faculty productivity, research, teaching responsibilities in major programs, as well as demographic information about science and mathematics faculty, information about their career paths, and their likelihood of leaving the teaching profession. The Earned Doctorates Survey ($160,000 requested for 1990, the same as the 1989 appropriation), which NCES cosponsors with NSF, NEH, NIH, and USDA, reveals annually the number of Ph.Ds in various fields of specialization, demographic information, and career plans. The Schools and Staffing Survey ($1.3 million requested for 1990, a $100,000 increase over 1989) provides data on changes in demand for mathematics and science teachers, changes in high school graduation requirements, characteristics of mathematics and science teachers (including career histories and plans, degrees earned, number and types of courses taken in mathematics and science, teaching experience, compensation, working conditions, courses taught, and other information).

Since fiscal year 1986, the National Science Foundation has funded a supplement to the National Education Longitudinal Study of 1988 (NELS:88), which provides feedback on the nature and quality of mathematics and science courses offered, by school attended. The NSF contribution to this effort rose from $115,000 in FY86 to nearly $250,000 in FY89.

Much of the data supplied at the outset of this article

come from NCES-supported projects, namely the National Assessment of Educational Progress. NCES is currently planning the groundbreaking 1990 National Assessment of Educational Progress, which for the first time will provide national data comparable state-by-state on what 8th graders know and can do in mathematics. The knowledge and efforts of NSF, CCSSO, and 18 education organizations, as well as NCES and others in the Department, went into determining the design, the objectives, and other dimensions of the state-by-state assessment. Plans are also under way for another international assessment of educational progress in mathematics and science, which will involve students aged 9 and 13 in 21 countries. Like its predecessor, this international assessment will be co-funded by NSF.

President Bush supports expanding NAEP so that the performance of American students in mathematics, science, and other academic subjects can be compared across state boundaries. The 1990 funding request for NAEP is $12.1 million, a $2.7 million increase over fiscal year 1989.

Let me talk now about the President's initiatives, including the legislative package the Administration sent to the Congress recently, the Educational Excellence Act of 1989. Six of the President's initiatives would influence mathematics or science teaching and learning directly or indirectly.

The $5 million National Science Scholars program (which would probably be administered by the Office of Postsecondary Education) would provide 570 grants of up to $10,000 a year for each year of undergraduate study to students who excel in mathematics and science. The high visibility and prestige of these awards would attract the attention of educators, students, and the American public in focusing on science and mathematics effort and achievement.

The $25 million Alternative Teacher and Principal Certification Program (to be administered in OERI) would provide grants to states for the purpose of developing alternate certification programs like the successful provisional certification program in New Jersey, which last year certified 29 percent of the state's new teachers. The New Jersey program and others like it have proven successful in attracting into teaching knowledgeable individuals, a high proportion of whom are minorities and many of whom have actual work experience in math- and science-related fields. The New Jersey program has virtually eliminated "emergency certification" and has greatly reduced teacher shortages in key areas such as science and mathematics.

The $100 million Magnet Schools of Excellence program (which would likely be administered by the Office of Elementary and Secondary Education) would make available

grants to states, who would then award funds on a competitive basis to school districts for schools offering students special curricula, including mathematics and science.

The $13 million Experiments for Educational Achievement program (to be administered in OERI) would support innovations and data collections to help states and local school systems identify and expand what works in their schools. Experiments would address issues across the full spectrum of educational innovations, including mathematics and science curriculum design, teaching and learning methods in mathematics and science, and other issues.

Whereas the other initiatives in the President's proposal do not mention mathematics or science explicitly, at least two would affect teaching and learning in these two disciplines. The Merit Schools program--by providing $250 million for national recognition and financial rewards to schools that increase the performance of disadvantaged youngsters--would offer schools a clear incentive to improve these youngsters' learning in mathematics (since standardized test scores will be one criterion of school performance and all such tests include mathematics). The $8 million Presidential Awards for Excellence in Education may not be limited exclusively to mathematics and science teachers; however, the program is likely to select a fair proportion of teachers in these shortage areas. (Both the Merit School program and the Presidential Awards for Excellence in Education program would probably be administered by the Office of Elementary and Secondary Education).

As reflected in these six initiatives, mathematics and science education rank high among the President's priorities in education. Mathematics and science are among Secretary Cavazos' top concerns as well. In releasing the annual Wall Chart in May, the Secretary set forth eight challenges for the nation, including this: "We must increase by half the number of children who perform at proficient levels in reading, mathematics, and science."

The Secretary issued several other challenges that would help make that goal possible. He stated that "We must clearly define what every student must know and be able to do before leaving the elementary, junior high, and high school levels." And he spoke, as he often does, about the importance of parent involvement in education, and about the wisdom of offering families incentives for seeking the best education for their children.

The education policies of President Bush and Secretary Cavazos are aimed at improving American education and promoting enduring American values--parent choice and involvement in education; state and local efforts to improve

school performance; and ultimately, higher levels of learning and literacy for all students in mathematics, science, and other basic academic subjects. The President has said that the Federal role in education is "to act as a catalyst for excellence in education." The four education themes of his Educational Excellence Act of 1989--incentives for schools and the people in them to pursue excellence; help for those who need it most; flexibility and choice for both parents and educators; and accountability for performance--will stimulate the desire and pursuit of higher levels of academic achievement. These themes also point the Department in a clear direction as we endeavor to improve and amplify the impact of our work.